

**Roscoe Bartlett**  
**Congressional Record**  
**PEAK OIL**  
**House of Representatives**  
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**@12:25 pm Eastern**

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The SPEAKER pro tempore. Under the Speaker's announced policy of January 18, 2007, the gentleman from Maryland (Mr. *Bartlett*) is recognized for 60 minutes as the designee of the minority leader.

Mr. BARTLETT of Maryland. Mr. Speaker, I believe that this is the 38th time that I've come to the floor to talk to my colleagues and, through the miracle of television, to the American people about a phenomenon that is becoming more and more apparent and more and more important to us.

This phenomenon is what we call peak oil. When I first started talking about this, I wasn't even sure what we were going to call it, the great rollover at that point in time when we've reached our maximum production to produce oil and we're rolling over to slip down the other side of that slope, or peak oil. We decided to call it peak oil, and now that is a pretty well-known terminology around the world.

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When I first started talking about this, oil was \$40 a barrel. Now oil is over \$100 a barrel. In our Frederick News Post, a local paper, a headline today says: ``Oil Spikes Above \$102 a Barrel for the First Time." As I left my office, oil was above \$101 a barrel and going up. The euro was, I think, \$1.51; gold was about \$960.

And America doesn't seem to be responding. I asked one of my colleagues why, and he said, well, it's a problem of addiction. We're addicted to oil. The President appropriately said that in one of his State of the Union messages. He said, when you're addicted, what it costs really doesn't matter. If you're addicted to alcohol or cocaine, if it costs you your marriage, your job, your house, meeting the demands of the addiction is the important thing.

The chart that I have here I think shows the problem. The disgruntled citizen is down here saying, ``Gee, just why is gas so expensive?" More than \$3 a gallon. And there it is, a tiny little supply and a huge demand. It's a matter of supply and demand. In the time that I have been

talking about peak oil, when it has risen from \$40 a barrel to over \$100 a barrel, the production of oil worldwide has remained essentially constant while the demand has been increasing. And when that happens, of course, there will be an increase in price; and we have seen that increase in price.

The next chart kind of places this in a perspective, and what it shows is the enormous importance of energy from fossil fuels, particularly the energy from gas and oil, enormous importance to the economies of the world. In 8,000 years of recorded history, I show here about the last 400 years. If I went back the rest of the 8,000, it would be the same. So near zero you couldn't see the difference. And here we show the beginning of the Industrial Revolution. It began with wood and then coal, and it was stuttering a little with coal, and then we discovered gas and oil, and, wow, it took off. Look at that slope. Incredibly, during the Carter years and up to that time, every decade we used as much oil as we had used in all of previous history.

Mr. Speaker, if you reflect for a moment on what that means, what that means is that when we had pumped half of all the oil that would be pumped in the world, we then would have 10 years left. Now, we have become much more efficient since then, and that was induced by the oil price spike hikes of the 1970s and the world-wide recession that followed, that, and an attention to efficiency, and your air conditioner and refrigerator are probably three times as efficient as they were back then.

If we had a population graph, you would see the population following this, now nearly 7 billion people in the world, most of us living incredibly well. Each person in our country has a life-style that if it were not for fossil fuels would require the work of 300 faithful people powering the industry and manning your household to permit you to live the quality of life that you're living.

That's the amount of energy that we get from these fossil fuels. One barrel of oil has the energy equivalent of 12 people working all year, 25,000 man hours of effort. When I first saw that, I thought that can't be true. Just 42 gallons of oil and has the energy equivalent of 12 people working all year? And then I thought about my Prius car and how far that gallon of gasoline, still cheaper than water in the grocery store if you buy it in the little bottles, how far that takes my Prius, 47 miles averaging now over the last 15,000, 20,000 miles.

Now, I could pull my Prius 47 miles, but it would take me quite a while with come-a-longs and using the guard rail and trees and so forth to pull my Prius 70 miles. So I thought maybe that is true. And that is true, that each barrel of oil contains the energy equivalent of 12 people working all year. So our use of this fossil fuel energy has produced for us an incredible quality of life.

The next chart is a history of how we got here, and this begins about 51 years ago, a speech given by M. King Hubbert to a group of oil people in San Antonio, Texas, on the 8th day of March, when he predicted in 1956 that we would be peaking in our country in oil production by 1970. Nobody believed that. We were then king of oil, producing more oil than any other country in the world, consuming more, exporting more. But right on schedule, in 1970, we peaked in oil production.

In spite of two things, in spite of finding a good deal more oil in Alaska and a good deal more oil in the Gulf of Mexico, this is the Alaska oil and this yellow is the Gulf of Mexico oil, and in spite of finding considerable oil in those two places, we now are producing about half the oil that we produced in 1970. And that's also in spite of drilling more oil wells than all the rest of the world put together. We have about 530,000 producing oil wells in our country, and that's more than all the rest of the world put together.

The next chart is an interesting one because it again shows what is referred to as Hubbert's Peak; and if you want to know a lot about this, you can do a Google search for Hubbert or Hubbert's Peak and a lot of this information will pop up for you.

The yellow triangles here represent M. King Hubbert's prediction of what oil production would be. The green is the actual production, and the red shows the total production from the United States including Alaska and the Gulf of Mexico, because M. King Hubbert had not included Alaska and the Gulf of Mexico in his analysis. This chart is presented by CERA to convince you that you shouldn't be too concerned about M. King Hubbert's prediction that the world would be peaking about now because he was wrong about the United States, and I think this is a statistician's debate because they're making the point that those green squares are materially different than the yellow triangles.

Now, I've had a course, an advanced course, in statistics; and I might, using the magic of statistical math, prove to myself that there is a meaningful difference there; but, boy, just looking at that, I think that the green curve looks pretty much like the yellow curve, doesn't it? We produced a bit more with Alaska and the Gulf of Mexico, but that was just a blip in sliding down the other side of Hubbert's Peak, and there we are today at about half of the production that we had in 1970.

The next graph shows us the reality of where we are. And if you had only one chart to look at, this would be that chart. It's said that a picture's worth a

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thousand words, and this is worth more than a thousand words. The little bars here show when we found the oil. And you see we started to find a lot of it in the 1940s and the 1950s; and, boy, did we find it in the 1960s and another peak in the 1980s. And ever since the 1980s, in spite of ever better techniques for finding oil, it's been down, down, down.

The solid line here represents our consumption of oil. It's the same chart that you saw previously. And this shows what happened in the 1970s. And it shows here dramatically the difference in the slope. We were increasing our use of oil at this rate. And you see if we had continued that, by now it would be off the chart, wouldn't it? Just extrapolate from this curve and you're off the chart. But we really learned how to be more efficient in the 1970s; so now the growth rate is about 2 percent a year and much slower than that.

Now, what will the future look like? Ever since 1980 we have been using more oil than we found. And the difference between what we found and what we used is made up from reserves. We're now pumping some of these reserves from the past.

What will future discoveries be like? These forecasters have indicated slowly declining production. It won't be smooth like that, but will probably average about like that because most experts that I know believe that we have probably found about 95 percent of all of the really recoverable oil that we will find in the world unless the prices are very high and we have technologies that are now only conceptual.

So what the future will look like will depend upon how quickly you think we can and ought to use these reserves because the difference between what we use, and, of course, you can't use what's not pumped, but the difference between what we use and what is available to use is this space in here, and that's going to be filled up by the reserves back here. With enhanced recovery and aggressive techniques of pumping live steam down there and sequestering CO<sub>2</sub> down there and flooding it with seawater the way they're doing it in Saudi Arabia, we might get it more quickly and we might get a little more of it, but it won't dramatically change what the future looks like.

The next chart is a schematic, which I think shows where we are, and this is again what we've referred to as Hubbert's Peak. And it reflects a 2 percent growth and decline after that. Now, you can make this peak look sharp or flat. Here we have expanded the abscissa and compressed the ordinate so that it's kind of flat. You can make it a really sharp peak if you do the reverse, but that yellow area there represents 35 years because, you see, 2 percent growth, just 2 percent growth, which is so small that our market really doesn't like that, if it's only 2 percent growth, Wall Street doesn't do very well. But 2 percent growth doubles in 35 years. It's four times bigger in 70 years. It's eight times bigger in 105 years. It is 16 times bigger in 140 years.

Now, we've been here a long time, and I hope we're here another 140 years; and if we have only 2 percent growth, we would be using 16 times as much energy in 140 years from now. I will tell you categorically there will not be 16 times as much energy to use so things in the interim will need to change. I think we're about here, and I will present evidence from a number of sources that corroborate that.

And most people are now concentrating on how do we fill the gap. Because with our addiction to these fossil fuels, this is what we would like to use, but we're only going to have this much available; so we have got to somehow fill in that gap. I will tell you that as far as liquid fuels are concerned, I don't think there's a prayer that we can fill in that gap. I think that we will be more than lucky if we can continue with a plateau, that what we can get from oil will be this curve and we can now have some renewables which will fill in to give us a plateau. We can live very comfortably with that. A chart a little later will show that.

The next chart is an interesting one. It's by a major organization, CERA, and they're one of the few entities in the world now that still is kind of in denial on peak oil. Although they say that, undulating plateau versus peak oil, but what they're showing there is a peak. And what they're showing here is that if we don't find much more oil, because we've found roughly 2 trillion barrels of recoverable oil and we've used a trillion barrels of those and that's just 1.92 trillion, and so if we find oil as depicted in that earlier chart we showed, then peaking would occur about here, which is imminent, is it not?

Now, if we find as much more oil as all the recoverable oil that still remains to be pumped, then that moves the peak out to this point. That's my kids. That's not even my grandkids. That's my kids that will have to deal with that. Even if that is true, then there's some unconventional oil, and I have no idea how much of that we can exploit. There are huge reserves in the Canadian tar sands and our oil shales of the West, Utah and Colorado. Heroic attempts are being made to exploit those. We're getting about a million barrels a day. That seems big, but the world is using more than 84 million barrels a day, and I just don't know what the potential will be. It is very uncertain what that potential will be. They are huge potential amounts of energy, but so are there huge potential amounts of energy in the tides. Because it's in the tides doesn't mean it's in the gas tank of your car, and the same thing is relatively true of these alternative sources of unconventional oil. Now, that also includes the heavy sour, and those we are converting and can convert; so there's some of that there too.

The next chart is a very recent one and very informative. [from The Oil Drum]

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There are two major entities in the world that track production and use. And, of course, the use and production are essentially the same thing because we have no big reserves of oil in the world. We are kind of using it as we produce it because we are hungry for oil in our economy. One of those is the IEA, the International Energy Agency, and El Baradei, and that is the one that is keeping track of what is going on with the nuclear thing in Iran, and you see them frequently in the news. And the other is our own Energy Information Administration, a part of our Department of Energy. And I would caution you to be kind of suspect on their predictions for the future because they are using what I think, and what a good many think, are highly speculative prognostications by USGS as to how much more oil we are going to find. But they do a very good job of tracking.

And look what they have found. Look what they have found. If you smooth out the ups and downs of the red and the green, the red for IEA and the green for the EIA, we have been essentially plateaued in oil production for the last 30 months. Now, in the same 30 months, that is about the time it took oil to go from \$40 a barrel to \$102 a barrel. And isn't that what happens when you have a static supply and an increasing demand? If there is inadequate supply for the demand, the price goes up. The little blue line here shows the cost of oil. And it is now above \$100 a barrel there, and it shows how dramatically the cost of oil responds to the availability of oil. There are a number of experts.

The next chart shows a quote, a very recent quote from Shell Oil Company, "By the year 2100, the world's energy system will be radically different from today." It will indeed be radically different from today's. The world's current predicament limits our maneuvering room. We are experiencing a step change in the growth rate of our energy demands. And Shell estimates that after 2015," that is just around the corner, "supplies of easy-to-access oil and gas will no longer keep up with demand." That is Shell Oil Company saying that we are going to peak out in the very near future in the production of gas and oil. We will not be able to meet the world's demands.

The next chart is a quote from our Secretary of State, Condoleezza Rice, noting the incredible geopolitical consequences. ``Yes, we do have to do something about the energy problem. I can tell you that nothing has really taken me aback more as Secretary of the State than the way the politics of energy is. I will use the word warping diplomacy around the world. We have simply got to do something now about the warping now of diplomatic effort by the all-out rush for energy supply." In 2006. We are now nearly 2 years later, and I will submit this was a very appropriate warning. We have done little.

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The next chart is a really illustrative one, and this chart shows what our world would look like if the size of the country was relative to the amount of oil reserves that it contained. And you see in this chart that Saudi Arabia dominates the landmass of the world. Indeed, 22 percent of all the oil reserves in the world we believe are in Saudi Arabia. And notice how large Iran, Iraq, Kuwait, and the United Arab Emirates, just little dots on the map in the Middle East, and look how large they are in terms of how much oil they have. Venezuela, in our hemisphere, dwarfs the United States.

Here we are with 2 percent of the oil in the world, and the yellow indicates that we use a whole lot. Why, we are the only yellow one in the world, aren't we? We have 2 percent of the oil. We use 25 percent of the world's oil. This is a shocking picture.

The next chart shows the concerns of some of our leading thought people in our country on the implications of this for national security. Jim Woolsey, McFarland, and Boyden Gray and 27 other prominent Americans, several Four Star retired admirals and generals among them, about 3 years ago wrote a letter to the President saying, ``Mr. President, the fact that we have only 2 percent of the world's reserves of oil and we consume 25 percent of the world's oil and import almost two-thirds of what we use is a totally unacceptable national security exposure. We really have to do something about that." The President mentioned that in his State of the Union that we were addicted to oil, much of it coming from people, as he said, that don't even like us very much. And we really need to do something about that. Tragically, we have not done much about that.

We represent less than 5 percent of the world's population, one person out of 22 in the world. We use a fourth of the world's oil. That statistic is not lost on the rest of the world, by the way. They note that, that they're paying \$8 a gallon for gasoline in France. We are still paying \$3 in our country. Note that although we have only 2 percent of the world's oil reserves, we are using 8 percent of the world's oil. What that means, of course, is that we are pumping our oil four times faster than the average in the world. That is understandable since we have more oil wells in our country than all the rest of the world put together.

The next chart really is an illustrative one [from GAO Report GAO-07-283]. It has two bars. And the bar on the right, the top ten oil and gas companies on the basis of oil reserves, and notice that 98 percent of all of the oil reserves, this is among the top ten, 98 percent of all the oil reserves are Middle East. Lukoil, Russia, has only 2 percent. So that is who has the oil.

Now, who pumps the oil? Gee, we think that ExxonMobil, Royal Dutch Shell, and BP and so forth are huge companies. They are huge companies. But look, 78 percent of the top ten producers of oil, again, are these countries in the Middle East that are big giants, produce only 22 percent of the oil.

The next chart is a quote from a speech given 51 years ago the 14th day of this May by Hyman Rickover to a group of physicians in St. Paul, Minnesota. And if you do a Google search for ``Rickover energy speech," it will pop up, an enormously prophetic speech. He noted that at that time we were about 100 years into the age of oil, and he had no idea how long the age of oil would last, but this is a quote. ``There is nothing man can do to rebuild exhausted fossil fuel reserves. They were created by solar energy a very long time ago and took eons to grow to their present volume."

“In the face of the basic fact that fossil fuel reserves are finite,” they are indeed finite. They are not inexhaustible. “The exact length of time these reserves will last is important in only one respect: The longer they last, the more time that we have to invent ways of living off renewable or substitute energy sources and to adjust our economy to the vast changes which we can expect from such a shift.”

He had no idea how long the age of oil would last. We were then 100 years into it. Now we pretty much know. With some confidence, I can tell you that the age of oil out of 8,000 years of recorded history will occupy about 300 years. As Hyman Rickover noted, this is but a blip in the long history of man. He said, ``Fossil fuels resemble capital in the bank. A prudent and responsible parent will use this capital sparingly in order to pass on to his children as much as possible of his inheritance. A selfish and irresponsible parent will squander it in riotous living and care not one whit how his offspring will fare." I have 10 kids, 16 grandkids, and two great grandkids. I am really concerned about their future relative to energy.

Do you know what we should have done when we found this incredible wealth under the ground, a barrel of which equaled the work output of 12 people working all year? We should have stopped to ask ourselves, what can we do with this to provide the most good for the most people for the longest time? That clearly is not what we did. With no more responsibility than the kids who found the cookie jar or the hog who found the feed room door open, we have just been pigging out.

And incredibly, with all the evidences that we have been going through here and more, that we are either at or very near peak oil, we still want to rush to drill and pump the last little reserves that we know might be out there. If we could pump ANWR and the offshore oil tomorrow, what we would do the day after tomorrow? And that is the plea that Hyman Rickover makes in his speech. There will be a day after tomorrow.

The next chart is an interesting one, and it shows some of the misconceptions that are out there. These are projections by our Energy Information Administration as to what production will be in the future. And we don't have time to go through the interesting transformation from frequency to probability, but somehow from USGS data to EIA charts, we went from a frequency to a P, which is a probability, and there they are making the bizarre statement that a 50 percent

probability is greater than a 95 percent probability. And of course that can't be true. And this is the 95 percent probability. This is the 50 percent probability.

And their projection is that world oil production, this is, by the way, a smoothing out that chart we saw before with a lot of discoveries around the 1970s and 1980s and they have just drawn a relatively smooth curve over that. They were projecting that we were going to find more and more, and we were going to follow the green line. But look what has been happening since they made this projection, what you would expect might be happening: 95 percent probable is more than 50 percent, and it has been following the 95 percent probability.

The next chart is an interesting observation from Jean Laherrere, who is an expert in this area. And he is looking at the prognostications that are used to project that green curve that we are going to find more and more, so don't worry about the future. He says that "the USGS estimate implies a five-fold increase in discovery rate and reserve addition for which no evidence is presented. Such an improvement in performance is, in fact, utterly implausible, given the great technological achievements of the industry over the past 20 years, computer modeling and 3-D seismic, the worldwide search and the deliberative effort to find the largest remaining prospects." Indeed, it really is quite implausible.

The next chart shows that even if that happened, even if that happened, even if we found as much more oil as all the known recoverable reserves today, it still wouldn't make that much difference. Because here we are, and here is that recession in the 1970s and our slower rate of increase because we are now more efficient. And the red curve indicates that we will find another roughly trillion barrels of oil, as much more oil as all the oil that we now know can be reasonably recovered. And if that happens, it pushes the peak out to 2016. Big deal, 9 years from now. That is the power of compound growth.

When Albert Einstein was asked, after the discovery of nuclear energy, Dr. Einstein, what will be the next big force in the universe? He said that the most powerful force in the universe is the power of compound interest. And you see that here.

And by the way, if we now use heroic efforts with enhanced recovery and we get it out quicker and maybe a little more, then it follows this curve, but then you pretty much fall off a cliff. You can't pump what is not there.

There have been four studies. The next chart is a quote from one of those

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studies. There have been four studies. The chart just up was a chart from that same study. There have been four studies paid for by your government, and pretty much ignored by your government. The first of these studies was the big study done by SAIC, known as the Hirsch report, published in 2005. And this is SAIC, a big prestigious organization of worldwide respect. He said that the world has never faced a problem like this. "World oil peaking is going to happen. World production of conventional oil will reach a maximum and decline thereafter." That happened in our country in 1970.



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The same man who predicted it would happen in our country in 1970 predicted it would be happening in the world about now. If he was right about our country, why shouldn't we have been concerned about the probability he might have been right about the world? "The world has never faced a problem like this."

The next chart shows a couple of more quotes from the Hirsch Report. "... will present the United States and world with unprecedented risk management problems, but the economic, social and political costs will be unprecedented." There is nothing in history to prepare us for this.

The three other reports, I mentioned that there were four, three other studies, actually, two reports from the Hirsch study, the second one was done by the Corps of Engineers, also in 2005. They said essentially the same thing in different words, that the peaking of oil is either present or imminent, with potentially devastating consequences.

The third one was by the Government Accountability Office in 2007, just last year, and they said essentially the same thing, in different words.

The last one was by the National Petroleum Council, again last year, saying essentially the same thing. "The peaking of oil is either present or imminent with potentially devastating consequences."

I have here I think a couple of more references to this very recent reference. Here is one. This is just out from the Deutsche Bank. There are several quotes in that, and you can pull this up and look at it. The 100 million barrels per day peak oil market, we are now somewhere 84 and 88 million barrels a day. We use about a fourth of that, 21-22 million barrels a day. I am not sure we will ever get to 100. But many people are prognosticating 120-150 million barrels a day. There is little probability that will happen.

Several CEOs are quoted in this of the large oil producing companies, and they are all saying essentially the same thing, that we are probably at peak oil.

Now, what do we do about that? I want to use the remaining time to talk about that.

The next chart is a chart of where we get our energy from today. Well, this was in 2004. That isn't quite today, and there have been some changes since then. But you can see we were getting, according to this chart, 23 percent of our energy from natural gas, 40 percent from petroleum, and from coal we got 23 percent. That adds up to 84-85 percent of all the energy that we are consuming comes from fossil fuels, and they are finite. They will not last forever.

Only 6 percent of that energy comes from true renewables, of the additional energy, to make up to 100, and 8 percent comes from nuclear electrical power. Now, that is 8 percent of the total energy in our country. That is almost 20 percent of our electricity is produced from nuclear power.

We are very much like the young couple whose grandparents have died and left them a big inheritance, and they now have established a really lavish lifestyle, where 85 percent of the money they are spending comes from their grandparents' inheritance and only 15 percent of it from their income. They look at what they are spending and how old they are and when they will retire, and, ``gee, the inheritance is going to run out before we retire, so we really got to do something. Either we got to spend less or make more." And that is precisely where we are.

This 85 percent, because we are reaching the maximum production of oil and gas, we will be tailing off, so there will be the necessity of replacing that. Just as this young couple would have to replace the limited resources in their grandparents' inheritance with more money or spend less money, that is where we are.

Now, these roughly represent the renewables. This was the picture in 2004. It has changed a little. But in terms of the big picture, the dramatic changes since 2004 are really pretty trifling.

At that time, solar represented 1 percent. Solar has been growing 20-25 percent a year. That is really big growth. But 1 percent of 7 percent is .07 percent. So it is five times bigger, 0.35 percent. Still trifling, isn't it? Still way down, kind of in the noise level.

Biomass/Wood. This is mainly the paper industry and timber industry wisely using what would otherwise be a waste product, waste to energy. You can do several things with your public waste, and burying it is probably the least productive thing you ought to do with it. You can recycle it, and that ought to be done, to the extent that it is rational. Or you can burn it to produce energy.

But be cautious. This is not a solution to our fossil fuel problem, because most of that waste stream represents the profligate use of fossil fuel energy, and in a fossil fuel deficient world, it just won't be there. So for the moment it makes imminently good sense to do that, but recognize that will be a diminishing resource. As the world has less and less fossil fuels, we are learn to live with less and less waste.

Wind. Boy, that one is growing, maybe 40 percent a year. Denmark is the world leader in that. They have now freed themselves from the need of imported oil. Their huge wind machines produce electricity at about 1.5 cents a kilowatt hour. We are doing it for about 2.5 cents a kilowatt hour. That is very competitive. And there is the potential for a lot of growth. Again, in 2004, that was only 1 percent of the 7 percent renewables, which is 0.07 percent. So to get to be a really meaningful percent of our total energy production, we have to have a long time and huge growth there, don't we?

Conventional hydro, you see that is a big part of the renewables. That is truly renewable. As long as the sun shines and the water evaporates and it is carried up to the clouds and it drops on the mountains and flows down to the rivers, we have conventional hydro. That probably can't grow much in our country. But we could grow micro hydro. The big macro hydro, we probably tapped out on it. But the rest of the world has some potential for growth in hydro.

Alcohol fuel, just spend a moment talking about that. This seems like such a great idea. Our farmers are so good at growing these grains, and you can ferment the sugar and corn to make

alcohol. The first cars that Henry Ford built ran on alcohol, so we are kind of just going full cycle if we turn back to alcohol.

We produced a fair amount of alcohol, and it doubled the price of corn. So our farmers, recognizing they could make more money growing corn than they could soybeans and wheat, they diverted land from soybeans and wheat at the same time that the world population is growing and the demands for these things are increasing.

So now we have an increase, double the price of corn, and a huge increase in the price of wheat and soybeans. And what that means is that three of the world's staple foods for people, corn, wheat, soybeans and rice, three of those have gone up because of our corn ethanol program. A UN official, noting what we had done and the consequences of this and the world increase in corn, wheat and soybean prices, said what we have done is a crime against humanity.

The National Academy of Sciences, now, this isn't Roscoe Bartlett saying this, I am just repeating the National Academy of Sciences, although we did some back-of-the-envelope computations and came to essentially the same conclusion, the National Academy of Sciences says if we took all of our corn and converted it to ethanol, and discounted it for fossil fuel input, which you really have to do to be fair, you can't be using fossil fuel energy to produce ethanol and pretend you are displacing fossil fuels, that we would in that case displace 2.4 percent of our gasoline.

That is trifling. In fact, it is so trifling that they noted that if you tuned up your car and put air in the tires, you would save as much gas as converting all of our corn to ethanol.

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They further said that if we converted all of our soybeans, no soybean oil for your salads, no soybean oil meal for your pigs and chickens and cows, converted all, but you still have the soybean meal left that you could use, but all the oil, convert all the oil to soy diesel, it would displace 2.9 percent of our diesel.

The reality is that these fossil fuels are incredibly rich in quality and quantity of energy. They have been easily exploitable. You put in our big oil fields one unit of energy and you get out 100 units of energy. It is the energy-profit ratio. In many of our wells today, we put in 1 and get out 1.5 or 1.2, but it is still profitable, so we still do it.

Geothermal. Now, that is true geothermal. That is not tying your heat pump to the ground temperature, which we really ought to do. When I got up this morning it was 18 degrees. If you had a heat pump, what you were trying to do to heat your house was to cool that 18 degrees outside. You had to take heat from out there and put it in your house.

Now, if you were tied to the ground, here it is 56 degrees. That looks really warm compared to 18, doesn't it? And the reverse in summer, of course. Your air conditioner in summer is trying to heat up that 102 air outside to cool your house. It would be a whole lot easier to work against a 56 degree ground temperature, wouldn't it? But this is talking about the true geothermal. That is where you are tapping into the heat produced in the molten core of the Earth.

Now, for all practical purposes, that is inexhaustible. It is not, of course, but you are talking in terms of millions and millions of years, so as far as we are concerned, it is inexhaustible. We have some real potential for that. There is not a chimney in Iceland that I saw, because they run everything there on geothermal. We have some places in our country where we can do that, and we can and should.

The next chart is a look at all of the potential substitutes, supplements, for fossil fuels. The first of these are some finite solutions, and that is the tar sands and the oil shales and coal. It is worth just spending a couple of minutes talking about those, because there are potentially huge, huge reserves there.

Conservatively, there are probably 1.5 trillion barrels of oil at both the tar sands and the oil shales, in each of those. There are potentially about 1.5 trillion barrels of oil in both the oil shales and tar sands. That is 3 trillion barrels between the two. And we have about 1 trillion barrels of recoverable oil in the known oil fields in the world. That is a huge amount, and some people will tell you, don't worry about the future, because we have all that oil there and we will get it out.

Well, they are working very heroically in Canada to exploit the tar sands. They have a shovel up there which lifts 100 tons at a time, they dump it into a truck which hauls 400 tons, and they haul it to a cooker that uses natural gas and cooks this really stiff oil so it will flow, and then they add some chemicals to it to keep it flowing when it cools.

They are producing about 1 million barrels a day. But they know what they are doing is not sustainable, because they are going to run out of the water it takes to do it, they are going to run out of the natural gas that they are using, and they are talking about building a nuclear power plant. And this seam, if you think of it as a seam, it is pretty much on top of the ground, but soon it ducks under an overlay and it would be prohibitively expensive to remove the overlay, so they will have to determine how to do it in situ, and they don't know how they can do that in situ. So because it is there doesn't mean it will be in your gas tank. But we really need to work at that.

But with these heroic methods, it is 1 million barrels a day. That is just a little over 1 percent of all the oil we use. So don't become too sanguine about the future because it is there, because there are huge engineering challenges in exploiting it.

The oil shales of our West, and conservatively there is 1.5 trillion barrels there, but to date nobody has found a way to competitively get that out, even with oil near \$100 a barrel. There are several companies and consortiums working on some breakthrough technologies that may make exploitation of that possible. But there is still an enormous amount of uncertainty in that, and to bank on that solving your energy problems would be sort of the equivalent of banking on winning the lottery to solve your personal economic problems. It would be real nice if that happened.

But I wouldn't bet the ranch on it. You ought to have a plan B, so I think we ought to have a plan B here.

Whoa, some people will tell you, no problem about the future, because we have 500 years of coal. That isn't true. There is nobody I know who believes we have 500 years.

But for a long time the figure 250 years was tossed about. That's 250 years at present use rates. There may be a chart later that shows this, but I will just go through the numbers now because they are really simple to understand. That 250 years shrinks to 85 years if there is only 2 percent growth.

Again, that's the power of compound growth. Then if you convert that coal to a gas or liquid and use the energy from coal to do it, which is the only fair thing to do, you have now shrunk to 50 years. If you share it with the world, and if you think about it, you think about it, there is no way you can avoid sharing it with the world. Because if we use oil produced from coal, then the oil we might have bought from the Middle East is available to somebody else.

So the end result is just as if you had sold three-fourths of that oil to the rest of the world, the oil they would get from coal, because they will be buying that three-fourths you didn't use from the countries from which you would have bought it. In that case it lasts 12 1/2 years.

But just recently, the National Academy of Sciences has said that we haven't really looked at coal reserves since the 1970s. And they have looked at coal reserves, and they say it's not 250 years of reserves, it's 100 years of reserves.

So if we use that same dynamic of compound growth, that 100 years shrinks to something probably less than 5 years if you convert it to a gas or liquid, use energy from coal to do that, and share it with the world.

Now, there is a lot of coal out there, and we are fortunate in being one of the major repositories of coal in the world, and you can convert it to a gas or a liquid. Germany did that during World War II. South Africa learned to do it when their trade was restricted with the rest the world. But this is not a panacea. It's there, and we will use it. But we need to use that as a bridge to get the true renewables.

Now, nuclear is kind of in a class by itself. There are three basic types of nuclear power plants; two of them we have, one of them is a dream. The two that we have is the light water reactor using fissionable uranium. That's the only one used worldwide to produce electricity. France produces about 75 or 80 percent of their electricity from nuclear. We still produce more electricity with our 20 percent than the total amount they produce because we are so much bigger than them.

By the way, and that uses fissionable uranium, and there is a finite amount of that in the world. It is not infinite. I get wildly divergent estimates of how much remain, but it's not in hundreds of years. It's in decades, not in hundreds of years.

A second type of nuclear energy is the breeder reactor, which, as the name implies, produces more fuel than it uses. That has been used in producing nuclear weapons in our country and other places in the world. It has big problems in transporting weapons, potentially weapons-grade materiel to enrichment and so forth, and of storing away some products that will be hot for a quarter of a million years.

Now, just intuitively, something so energetic that I can't get near it for a quarter of a million years just ought to have enough energy in there to do something useful with it, and they now are working at that, and there are now some exciting new technologies that may permit us to get a whole lot more energy out of these fuels than we were getting in the past. So there is a real opportunity for nuclear to kind of take up the slack, but note that that produces electricity.

Unless you are going to go to electric cars, that doesn't help much in liquid

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fuels, and the real crisis in the future, the real challenge for the future, is going to be liquid fuels. Now, the only silver bullet that I know of, and, again, this is not liquid fuels, but you can have electric cars, was some challenges in producing batteries and with the raw materials necessary for those and disposing of the batteries and so forth.

Fusion is inexhaustible, if we get to it. That's what the sun is doing. It's a huge nuclear fusion plant. We may get there. We spend about \$250 million a year doing that, and we are always about 30 years away from a functioning fusion power plant.

I gladly support the \$250 million, but I will tell you that I think the odds of getting there are relatively small. The rewards are so huge that it's worth the investment even if the chance of success is small, so I happily vote for this.

But please have a plan B. If we get there, wonderful. But the probability that we will get there is, I think, quite small, so we really need a plan B. You can't count on that as the future energy source for your kids and your grandkids.

Now, here are the renewables that we have been talking about. Let's see if there are some here. Ocean energy. Lots of potential from energy from the oceans, the ocean waves, the ocean tides. The Moon lifts the whole ocean, three-fourths of the Earth's surface, several feet a day.

I carry two 5-gallon buckets of water, that's heavy. When I think about the huge amount of potential energy in just those tides, it's more than we are using, but it's disbursed, very difficult to capture. There is an old axiom that says, energy, to be effective, must be concentrated when the tides are just so disbursed. Very difficult.

There is ocean thermal gradients. Some places the surface of the ocean is very warm, the deep waters are very cold, and you can, with the principle of the thermocouple, get energy from that divergent temperature difference. So there are a lot of opportunities, potential opportunities from energy from the ocean, and we ought to be exploiting all of those.

Methanol. Methanol is simply an alcohol made from wood rather than grain. Grain alcohol has two carbons, wood alcohol has one carbon, but it burns with roughly the same amount of energy.

A biomass, and a lot of talk about biomass today, and you look out there at all of that wasteland and those trees and that grass, and, gee, if we could just take that and convert it into alcohol. You can do that with some little organisms that we have bioengineered that mimic what the organisms do in the gut of the sheep or the goat or the cow or the cecum of the horse and the guinea pig. They can break down the cellulose molecule into the constituent glucose molecules. Then, of course, you can ferment those glucose molecules. But we have not yet perfected that technology so that it is amenable to huge, large-scale production, but maybe we can get there.

I have a major concern that Hyman Rickover talked about in his great speech, and again, I would urge that that's a very instructive speech. Hyman Rickover, energy speech, Google, search it. It will pop up for you.

He noted in that speech that we shouldn't be competing with food for energy. That's corn ethanol, biodiesel. We should be careful in competing with a humus for fuel, because, you see, the weeds that grow today in that vacant lot, that will grow this summer, are in at least some measure growing because last year's weeds died and are fertilizing them.

I remember back, I was born in 1926, so I lived during the Depression, and I remember farmers in the Depression which said, gee, I have now worn out my third farm. What they did was to go in and mine the farm simply by planting crops that drew from the soil far more energy than he or the plants put into the soil. So soon, the soils were nonproductive and there were few of us in a big country, and he just moved on.

You can't move on today, and so we have to have sustainable agriculture. I don't know the extent to which we can exploit what might be a huge potential from energy from biomass, but I would caution that we really need to look at sustainability.

If you have ever gone to the tropical rain forest that looks to be a hugely rich dynamic, and, gee, if I only could get all of that stuff off of there, I could grow tremendous crops on that soil.

But when they did that, there was bitter disappointment, because what they found was that essentially all of the nutrients in that ecosystem were involved in the growth, death, decay, regrowth. When they took that material off the soils, for what they called laterite soils, they baked like a brick. It would take a very long time by secondary succession to come back to a rain forest. We need to be very careful about sustainability.

I have been a big proponent of what we call ARPA-E, and we voted that. It's not been funded, and the administration is not recommending funding it, and I hope they reconsider.

ARPA-E kind of mimics our DARPA, which has been an enormously successful organization in exploiting leading-edge technologies, and the net out there is their creation. They have been the creator of a lot of really exciting technology, because what they do is to fund leading-edge

things that are so far out there and so risky that business rationally can't do it, and probably in terms of fidelity to their stockholders should not be doing it.

We think the future demands very creative approaches to selecting which of these alternatives we invest our limited amount of time and money and energy in.

My wife tells me that I shouldn't be talking about this. She said that don't you remember that in ancient Greece they killed the messenger that brought bad news. I tell her this is really a good news story. It's a good news story in two respects. One is that the sooner we start, the less bumpy the ride will be.

Now, we should have started at least 28 years ago. I say that because by 1980 we knew absolutely that M. King Hubbert was right about the United States. We were already 10 years down the other side of Hubbert's peak. We have now blown 28 years when he should have been doing something, but if we start today, the ride will be smoother than if we start tomorrow.

But even more importantly, I think this challenge is just exhilarating. There is no exhilaration like the exhilaration of meeting and overcoming a huge challenge, and, boy, this is a big one.

A year ago, the holiday season, I was privileged to lead a codel of nine Members to China, and we went there to talk about energy. Incredibly, they began their discussion of energy by talking about post oil. Gee, you know, in our country, we tend to think in terms of the next quarterly report, and the next election. We are kind of dominated by what's called the tyranny of the urgent, which frequently sweeps the important off the table. But in that part of the world they seem to think in terms of generations and centuries. And so with that perspective, they were talking about a post-oil world, and they talked about post oil, and they had a five-point plan.

Number one, conservation. That's where it has got to begin is conservation. That will buy some time and free up some energy because we have run out of time. There is no surplus energy to invest in alternatives. Their oil wouldn't be \$100 a barrel.

The second and third points of their five-point program was find alternatives, and as many of those as you can from their own country.

The fourth one will interest you, it's be kind to the environment, and they know that they are big polluters.

The fifth one is international cooperation. They are pleading for international cooperation.

What we need, and I will close with this brief statement, what we need is a program that has a total commitment of World War II, the technology focus of putting a man on the Moon, and the urgency of the Manhattan Project. We are the most creative, innovative society in the world. We are up to the challenge. We need leadership. We can do it.

*END*